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This report, a supplement to "Technical Report Number 82," is designed to aid the researcher concerned with concept learning. It contains: (1) a rationale and strategy for compiling a bibliography of articles concerned with concept learning; (2) a definition of the word 'concept'; (3) a system for classifying articles by their content; (4) a bibliography of relevant articles arranged alphabetically by author; and (5) a bibliography of the articles arranged according to their content. (Author)

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TECHNICAL REPORT NO. 147

A SUPPLEMENT TO TECHNICAL REPORT NO. 82

CONCEPT LEARNING: A BIBLIOGRAPHY, JULY - DECEMBER 1969

REPORT FROM THE PROJECT ON SITUATIONAL VARIABLES AND EFFICIENCY OF CONCEPT LEARNING

ED 046033

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CENTER FOR COGNITIVE LEARNING

THE UNIVERSITY OF WISCONSIN
Madison, Wisconsin

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UNIVERSITAS WISCONSINENSIS
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Technical Report No. 147

A SUPPLEMENT TO TECHNICAL REPORT NO. 82

CONCEPT LEARNING: A BIBLIOGRAPHY, July-December, 1969

Herbert J. Klausmeier, Pamela E. Robinson, Dorothy A. Frayer,
and Marjorie L. DeVault

Report from the Project on Situational Variables
and Efficiency of Concept Learning
Herbert J. Klausmeier and Robert E. Davidson, Principal Investigators

and the

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STATEMENT OF FOCUS

The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement of related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This Technical Report is from the Situational Variables and Efficiency of Concept Learning Project in Program 1. General objectives of the Program are to generate new knowledge about concept learning and cognitive skills, to synthesize existing knowledge, and to develop educational materials suggested by the prior activities.

Contributing to these Program objectives, the Concept Learning Project has the following five objectives: to identify the conditions that facilitate concept learning in the school setting and to describe their management, to develop and validate a schema for evaluating the student's level of concept understanding, to develop and validate a model of cognitive processes in concept learning, to generate knowledge concerning the semantic components of concept learning, and to identify conditions associated with motivation for school learning and to describe their management.

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ABSTRACT

This report, a supplement to *Technical Report No. 82*, is designed to aid the researcher concerned with concept learning. It contains (1) rationale and strategy for compiling a bibliography of articles concerned with concept learning, (2) a definition of the word *concept*, (3) a system for classifying articles by their content, (4) a bibliography of relevant articles arranged alphabetically by author, and (5) a bibliography of the articles arranged according to their content.

I
INTRODUCTION

This technical report is a supplement to *Technical Report No. 82* (Klausmeier, H. J., Sterrett, B. E., Frayer, D. A., Lewis, S. B., Lee, V. W., & Bavry, J. L., 1969). It contains (1) a definition of *concept*, (2) a bibliography of concept learning articles appearing in journals and Wisconsin R & D Center publications during the period July-December, 1969, (3) a system for classifying articles by content into areas of interest to the researcher, and (4) a listing of bibliographic entries grouped according to this classification system.

One primary interest of the Wisconsin Research and Development Center is to extend knowledge about the learning and teaching of concepts. An important step in this task is review of the literature concerned with concept learning. Review of the literature and cataloging of the relevant articles began immediately after the Center was established in September 1964. The results of this endeavor were published in *Technical Report No. 1* (Klausmeier, H. J., Davis, J. K., Ramsay, J. G., Fredrick, W. C., & Davies, M. H., 1965), which contained a bibliography of concept learning and problem-solving articles from selected journals for 1950-1964.

Early in the task of cataloging articles, it became apparent that a definition of *concept* was needed in order to specify more exactly what was to be included in this domain. Existing definitions of concept appeared inadequate as a basis for organizing present knowledge and suggesting additional research. Therefore, an analysis of *concept* in terms of its attributes was developed. This analysis of *concept* appears in Chapter II.

Recently, the concept learning section of the 1965 report was updated and expanded. The results have been published in *Technical Reports Nos. 82, 107,* and *120* of the Wisconsin Research and Development Center (Klausmeier, *et al.*, 1969 (a), (b), and 1970). Relevant articles of 1950 - June, 1969 journals were included in the reports. In addition to updating the concept learning bibliography of *Technical Report No. 1*, these reports were expanded by developing a classification system to provide more information about each article. Fifty-six areas of interest to the researcher in concept learning were identified. Each article was read to determine in which categories it should be included. Articles were then listed together under each appropriate category of the system.

The first step in compiling this bibliography was to systematically and comprehensively search the forty-nine selected journals and the R & D Center publications. The publications searched are listed in Chapter III. The text of each article in all issues was examined to determine whether the article met criteria established for inclusion in the bibliography. Criteria specified that the article was (1) to include the term(s) ***concept, concept formation, concept identification, concept attainment***, or ***conceptual learning*** in either (a) the title, (b) a subheading, (c) an abstract of the article, or (d) the summary or conclusion; (2) to be a controlled experiment or a theoretical article discussing and integrating empirical research; and (3) to use human subjects. The articles which met all of the established criteria were then arranged by content using the classification system described in Chapter IV.

The present report includes a listing of articles arranged alphabetically by author, in Chapter VI. The articles arranged according to content are listed in Chapter VII. An author index is included and should be helpful to anyone who wishes to locate the work of a particular author.

This technical report brings the search for and cataloging of articles through December, 1969. It is anticipated that additional annual supplements will be available in the future. Requests for supplements should be addressed to the Dissemination Section of the Wisconsin Research and Development Center for Cognitive Learning.

II
DEFINITION OF CONCEPT

Many people refer to a concept as an idea or abstraction and may, for clarification, give examples of concepts such as *dog*, *numeral*, *sentence*, and *reading readiness*. In line with the widespread practice of defining concepts by giving synonyms and examples, the preceding definition is acceptable for use with the general public.

In the psychological and educational literature one finds such definitions of concept as:

> The concept deals with the *meaning* an individual attaches to a word or other symbol, rather than with the mere fact that any given symbol is associated with any given object [Woodruff, 1951, p. 285].

> A concept may be regarded as a verbal habit-family formed usually on the basis of a class of stimulus objects having identical elements [Staats, 1961, p. 195].

> [A concept is the recognition of] a group of situations which have a resemblance or common element. We usually give a name or label to the group [Cronbach, 1954, p. 281].

> Concepts are learnings that permeate thinking [Russell, 1960, p. 323].

> . . . a concept exists whenever two or more distinguishable objects or events have been grouped or classified together and set apart from other objects on the basis of some common feature or property characteristic of each [Bourne, 1966, p. 1].

These excerpts of definitions indicate why one may become confused when attempting to delimit what is meant by *concept*. The term *concept* means many different things to many different individuals.

Objects and events may be put into the same category on the basis of their criterial attributes. The category is usually given a name. In turn, the word that represents the category may be defined in terms of the criterial attributes of the category. Such an approach may be used in deriving a definition of that class of learned behaviors represented by the word *concept*. Concepts have certain criterial attributes which differentiate them from other learning outcomes, such as facts. Klausmeier and Goodwin (1966) listed some of these attributes which are now treated briefly at a higher level of conceptualization.

BASIS OF DEFINITION

Words are used to represent concepts. In order that words convey the same or a similar meaning to individuals, it is necessary that there be agreement about the realities for which the words stand. Scholars in a discipline whose knowledge of the concepts is most complete use at least three bases for defining concepts.

First, concepts may be defined in terms of their intrinsic dimensions or attributes. These dimensions or attributes are abstracted as being alike or the same in otherwise dissimilar objects and thus define the concept from an objective point of view. For example, the attributes which allow some objects to be classified as oranges and others as lemons are size, color, shape, and taste. Similarly, the attributes useful in defining or putting many objects into the two classes squares and equilateral triangles are number of sides and length of sides. Living and nonliving things have been studied by naturalists and scientists. On the basis of observed attributes these things have been given names, assigned to classes, and organized into taxonomic systems—for example, the animal kingdom, the plant kingdom, the solar system, and the table of chemical elements.

Second, definition may be based on the use of the objects. For example, corn oil, strawberries, and beefsteak vary markedly according

to intrinsic properties, but all are categorized as food. Some scholars consider use as an intrinsic property of an object and therefore do not differentiate between the first and second bases of definition. Definition of concepts in terms of the use made of objects and ideas, however, is generally more tentative and culturally bound than is definition in terms of intrinsic properties. For example, more people properly classify pigs and cows as animals than pork and beefsteak as food.

Third, concepts may be defined in terms of behaviors or operations rather than attributes. This type of definition is prevalent in the behavioral sciences where many of the phenomena dealt with are internal processes that have no readily identifiable attributes. Examples of behavioral definitions of terms are the following: "Intelligence is the composite behavior measured by a test of general intellectual ability." "Hunger drive is an internal condition of the animal expressed as a linear function of the amount of time elapsed since food intake." Behavioral definitions are precise but different scholars may offer varying definitions for a given word.

In the preceding paragraphs, we have seen that concepts as represented in words and other symbols may be defined in terms of the observable attributes of objects or events, the uses made of them, or behaviors which permit inference of a concept. It is not the purpose here to treat the certainty of knowledge in various fields in terms of the methods used for defining concepts. Rather, the point is made that one attribute of *concept* is definability. Experts who know most about a discipline should be able to indicate the main concepts of the discipline, state the bases of definition, and arrange them according to preciseness of definition.

STRUCTURAL CHARACTERISTICS

Four important aspects of concept structure are the complexity of the attributes comprising the concept, the rules by which the attributes are joined to form the concept, the number of attributes joined, and the mode in which the examples of the concepts are experienced.

One way to look at the structure of concepts is in terms of what is joined. Think of the letters of the alphabet as *units*; of words like fish and fruit as representing *classes*; of words being joined into sentences by syntactical rules to express *relations*; and of relations being joined together in paragraphs to comprise *systems* that may be useful in describing, explaining, and the like. As one goes higher up the scale from units to classes to relations, the concepts become more complex. Being joined eventually are concepts into more complex concepts that some persons call generalizations, principles, or even theoretical statements.

A second characteristic of the structure of concepts is the type of rule by which the attributes are joined. Think of the concepts represented by the words *red*, *mammal*, *baseball strike*, and *older*. They differ in the number of attributes and the rules by which the attributes are joined. Red is a simple, affirmation type concept comprised of one dimension. Animals that manifest three attributes simultaneously or conjunctively—warm-blooded, mammary glands, bear young—are classified as mammals. A strike in baseball represents a concept where attributes are joined by a disjunctive rule, and/or. A strike may be a ball thrown in the strike zone and called by the umpire, or it may be a pitch swung at and missed, or it may be a foul tip. A five-year-old child is older than one of four years but younger than one of six. This is a relational type concept. These are only a few of the rules for joining the attributes of concepts and for joining simple concepts to form more complex concepts.

The number of attributes comprising a concept varies widely. Colors such as red and blue have only one dimension. Mammals have many attributes. Many subconcepts may be joined and relationships expressed among them as in the system by which vertebrates are put into various subclasses. In general, the greater the number of items joined, the more complex (and difficult to learn) is the concept.

The attributes of concepts may be represented in various forms. Words are being used here. Some attributes may be observed directly in figural content; that is they may be seen or heard as they actually exist. Some may also be manipulated or acted upon physically. The attributes of the concept *emotion* are perceived internally. Thus, attributes may not be equally available or open to the senses.

In summary, the structure of a concept is determined by the complexity of its attributes, the rule joining the attributes, the number of attributes, and the form in which instances of the concept are experienced. Concepts comprised of one or two attributes that may be directly observed in instances of the concept are least complex, or difficult, and may be learned early in life. Concepts comprised of several subconcepts that are joined by disjunctive rules, and that are represented only in words or other symbols, are most complex.

PSYCHOLOGICAL MEANINGFULNESS

Experts in a subject field might agree about the basis of definition, structure, and other dimensions of many concepts in the field. This agreement, however, would not indicate that all individuals possess the same concepts. Thus another dimension of concepts is individual, or phenomenological. Here there are two main concerns: (1) differences regarding the same concept among individuals and (2) changes that occur with increasing maturation and learning within the individual regarding the same concept.

Individuals of the same age vary widely in the accuracy and completeness of their concepts. For example, first-grade children's concepts of reading, school, and time vary considerably as a result of differing environmental and biological factors. Similarly, there is great variability among teachers' concepts of reading readiness, individualization of instruction, and pupil-teacher planning. Differences among individuals in the accuracy and completeness of concepts are well documented.

Children's ability to conceptualize changes with age. According to Piaget, the changes are qualitative; that is, at successive stages that can be very roughly identified with age, distinct changes occur in the kind of mental operations that children can perform.

Bruner has transplanted Piaget's ideas, developed in Europe, to the American setting. According to Bruner, the growing human being has three means of acting upon his environment: through direct action, through imagery, and through language. Individuals not only act upon the environment through these means but have appropriate internal counterparts in the central nervous system for representing sensory-motor acts, percepts, and thoughts. These internal representational schemes are designated *enactive*, *iconic*, and *symbolic*. In early life the child proceeds in this sequence. He apparently first acts upon objects, or manipulates them (enactive representation), before developing a mental image (iconic) of them, and then later associating names with the objects (symbolic). Although this sequence is typical of early life, one does not stop transacting with the environment through action and imagery. The enactive and iconic modes continue throughout life. However, with the development of language, one increasingly deals with his environment at the symbolic level.

Like Piaget, Bruner (1964) stated that enactive and iconic representation are characterized by immediacy. Objects and events in the immediate environment are represented in the cognitive structure. With language development comes the ability to represent experiences in words. This act in turn releases one from immediate transactions with the environment. Language also permits combinatorial mental operations in the absence of what is represented. Thus, higher-order productive thinking is possible and enables one to interconnect and organize experiences into increasingly inclusive and abstract hierarchies.

UTILITY

Of what value is it to have learned a concept? Bruner, Goodnow, and Austin (1956) have outlined five uses or functions of concepts. First, concepts serve to reduce environmental complexity by allowing classification into superordinate categories. Second, concepts are means by which environmental objects and events are identified. Third, concepts reduce the necessity of continual relearning by providing easily recallable class labels. Fourth, concepts provide direction for instrumental activity. Fifth, concepts permit ordering and relating classes of objects and events.

Not all concepts are equally useful or equally applicable to many situations. As pointed to previously in the discussion of structure, concepts can be ordered hierarchically according to the number and complexity of attributes that are joined, the rules for joining them, and the mode in which they are represented. Concepts at a high level function in more situations than those at lower levels in the hierarchy. For example, the concepts of plant and animal function in more situations than do those of tree and bird, respectively.

Most learning theorists in the previous decades have defined concepts in terms of only one or two of the characteristics of concepts discussed here. This discussion reflects the growing interest for studying concept learning in depth. It is hoped that this discussion will provide some direction for the researcher involved in the study of concept learning, by suggesting areas in which investigation is needed.

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III
LIST OF PUBLICATIONS SEARCHED

JOURNALS

Abbreviations accompanying the journal titles are those which appear in the bibliography.

Journal Title	Abbreviation
Acta Psychologica	Acta Psychol.
American Journal of Mental Deficiency	Amer. J. Ment. Defic.
American Journal of Psychology	Amer. J. Psychol.
American Psychologist	Amer. Psychol.
American Sociological Review	Amer. Sociol. Rev.
Annual Review of Psychology	Annu. Rev. Psychol.
Behavioral Science	Behav. Sci.
British Journal of Educational Psychology	Brit. J. Educ. Psychol.
British Journal of Psychology	Brit. J. Psychol.
Canadian Journal of Psychology	Canad. J. Psychol.
Child Development	Child Develpm.
Childhood Education	Childh. Educ.
Education	Educ.
Educational and Psychological Measurement	Educ. Psychol. Measmt.
Elementary School Journal	Elem. Sch. J.
Genetic Psychology Monographs	Genet. Psychol. Monogr.
Harvard Educational Review	Harv. Educ. Rev.
Journal of Abnormal Psychology	J. Abnorm. Psychol.
Journal of Applied Psychology	J. Appl. Psychol.
Journal of Clinical Psychology	J. Clin. Psychol.
Journal of Comparative and Physiological Psychology	J. Comp. Physiol. Psychol.
Journal of Consulting and Clinical Psychology	J. Consult. Clin. Psychol.
Journal of Educational Psychology	J. Educ. Psychol.
Journal of Educational Research	J. Educ. Res.
Journal of Experimental Child Psychology	J. Exp. Child Psychol.
Journal of Experimental Education	J. Exp. Educ.
Journal of Experimental Psychology	J. Exp. Psychol.
Journal of Experimental Research in Personality	J. Exp. Res. Per.
Journal of Experimental Social Psychology	J. Exp. Soc. Psychol.
Journal of General Psychology	J. Gen. Psychol.
Journal of Genetic Psychology	J. Genet. Psychol.
Journal of Nervous and Mental Disease	J. Nerv. Ment. Dis.
Journal of Personality	J. Pers.

Journal Title	Abbreviation
Journal of Personality and Social Psychology	J. Pers. soc. Psychol.
Journal of Psychology	J. Psychol.
Journal of Research in Science Teaching	J. Res. Sci. Teach.
Journal of Social Psychology	J. Soc. Psychol.
Journal of Verbal Learning and Verbal Behavior	J. Verbal Learn. Verbal Behav.
Organizational Behavior and Human Performance	Org. Behav. Hum. Perform.
Perceptual and Motor Skills	Percep. Mot. Skills
Psychological Bulletin	Psychol. Bull.
Psychological Record	Psychol. Rec.
Psychological Reports	Psychol. Rep.
Psychological Review	Psychol. Rev.
Psychonomic Science	Psychon. Sci.
Quarterly Journal of Experimental Psychology	Quart. J. Exp. Psychol.
Review of Educational Research	Rev. Educ. Res.
Scandinavian Journal of Psychology	Scand. J. Psychol.
Science Education	Sci. Educ.

PUBLICATIONS OF THE R&D CENTER

Publication Title	Abbreviation
Technical Report	Wis. R & D Cent. Cog. Learn. Tech. Rep.
Theoretical Paper	Wis. R & D Cent. Cog. Learn. Theo. Pap.
Working Paper	Wis. R & D Cent. Cog. Learn. Work. Pap.
Practical Paper	Wis. R & D Cent. Cog. Learn. Pract. Pap.

IV
CLASSIFICATION SYSTEM

The following classification system was developed to facilitate use of the bibliography. The categories of the system are the topics and variables which may be of interest to the concept learning researcher. Each article listed in the bibliography was read and placed in all appropriate categories.

First, experimental studies were classified according to the age of subjects employed. For each article reporting empirical research, the age category of the subjects was noted in the bibliographic entry.

Second, variables studied in a particular experiment were noted. Studies which compared subjects differing on characteristics such as mental age, achievement, cognitive style, etc., were listed under the appropriate *Subject Variable* heading. Experiments manipulating conditions of learning such as type of instructions, pretraining, feedback, etc., were listed under the relevant *Learning Situation* topic. When variables dealing with the nature of this learning task itself were studied, the article was listed under the applicable *Task Variable* classification. Research dealing with the nature of a concept was listed under a *Concept Relationships* heading.

Third, articles and studies relevant to classroom learning were categorized under *Academic Areas* into subject matter fields such as reading, mathematics, etc.

Fourth, studies employing atypical subjects such as the mentally retarded or emotionally disturbed were noted under the section *Abnormal Subject Characteristics*.

Fifth, experiments designed to elucidate concept learning phenomena such as discrimination, transfer, etc., were listed under the appropriate topic in the *Processes and Phenomena* section, as well as under the variables manipulated.

Finally, articles dealing with recurrent topics such as computer simulation, factor analysis, and Piagetian theory were listed together under *Specific Interests*.

Although it was impossible to list or even determine every area that might be useful to a researcher, these classifications should assist in his search of the literature. Within Part VII the fifty-six headings appear in a single alphabetical order. On this and the following page, the headings have been grouped under several main topics to alert the researcher to his primary area of interest.

SUBJECT AGE

PS - preschool age including nursery

ES - elementary school age including kindergarten

SS - secondary school age

AD - adults including college students

SUBJECT VARIABLES

Mental age differences

Achievement differences

Cognitive style differences

Age or grade differences

Sex comparisons

Physical characteristic differences

Affective characteristic differences

Socioeconomic status differences

Pre-experimental training differences

Anxiety level differences

LEARNING SITUATION VARIABLES

Instructions, information, or teaching method differences

Type and/or amount of pretraining and/or training differences

Type and/or amount of reward and/or feedback varied

Distraction or stress differences

TASK VARIABLES

Sequence of stimuli varied

Number of relevant or irrelevant dimensions varied

Variations within dimensions defining the concept

Comparison between dimensions defining the concept

Number of positive and/or negative instances varied

Number of instances varied

Method of presentation of stimuli varied

Sensory mode of presentation of stimuli varied

Shifts or concept switching

Learning set

Differences in mode of response

Differences in number of response categories

Redundancy of information

CONCEPT RELATIONSHIPS

Rules

Associative rank and dominance

Similarity

ACADEMIC AREAS

Language skills

Reading

Mathematics

Social studies

Science

ABNORMAL SUBJECT CHARACTERISTICS

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Physical disabilities

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PROCESSES AND PHENOMENA

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V

FORM OF BIBLIOGRAPHIC ENTRIES

The following sections of the report were produced by computer printout, necessitating some deviations from standard bibliographic form. Journal titles are abbreviated; volume numbers are not in boldface; issue numbers and whole numbers when applicable follow volume numbers and are separated from them by a slash. Because of space limitations, entries of articles authored by more than three persons contain only the first three authors followed by "*et al.*"

In Chapter VII, the listing according to classification system, the categories are arranged in alphabetical order. Within each category, articles are arranged alphabetically by author.

VI

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